Application No. 09/630,572

REMARKS

Reexamination and reconsideration is respectfully requested in light of the foregoing amendment to claim 4 and following remarks.

Claims 1-9 and 11 are pending in this application. Claim 10 was canceled by a previous amendment. It is proposed to amend claim 4 to correct an obvious antecedent error. It is the "selecting means," and not the "enhancement range determining means," that selects the weighting matrix. It is respectfully requested that the amendment be entered. The amendment does not raise an issue of new matter and does not require new consideration and/or search of the claimed subject matter.

Applicant notes the Examiner's acknowledgment of Applicant's claim for foreign priority under 35 U.S.C. § 119 and receipt of the certified priority document. Applicant further notes the Examiner's acceptance of the drawings filed August 3, 2003.

Rejection Over Kuwata et al.

Claims 1-9 and 11 stand rejected under 35 U.S.C. § 102(e) as being anticipated Kuwata et al. (U.S. Patent No. 6,392,759). Applicant respectfully traverses this rejection.

Claim 1 requires an "edge detecting means for determining the presence/absence of an edge at each pixel of input data and detecting a position of the edge at each edge pixel." The Examiner finds support for this feature of the invention at Fig. 1 and at col. 9, line, 65 to col. 10, line. 4 and at col. 10, line 5-12 of Kuwata et al. Fig. 1 discloses an image obtaining unit, a summation processing unit, an edge-enhancement element determination unit and an edge enhancement unit. The Examiner has not identified which of these units is the edge detecting means for determining the presence or absence of an edge of each pixel and detecting a position

of the edge. The reference at col. 9, line, 65 to col. 10, line. 4 and at col. 10, line. 5-12 discloses the following:

> Assuming that the image data is composed of pixels in dot matrix, each pixels [sic, pixel] is represented by multi-level RGB luminance data. At an edge portion of the image, the difference of the luminance data between adjacent pixels is large. The difference, which is a luminance gradient, is called an edge amount. As shown in FIG. 7, edge amounts are summed up while scanning the respective pixels constituting the image.
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> At step **S110**, the edge amount of the each pixel is judged. In case of considering an XY rectangular coordinates as shown in FIG. **8**, the vector of a image change level can be calculated by obtaining an X-axis directional component and a Y-axis directional component. In a digital image composed of pixels in dot matrix, the pixels are adjacent to each other in a vertical axial direction and a lateral axial direction as shown in FIG. **9**.

The Examiner has not explained how this disclosure teaches or discloses an edge detecting means for determining the presence or absence of an edge of each pixel and detecting a position of the edge. The Kuwata et al. disclosure describes an "edge portion" of the image and a step S110 for determining the edge amount or luminance gradients, but not of a means for detecting the <u>presence or absence of an edge of a pixel</u>, let alone detecting a <u>position of the edge</u>. The x and y parameters are not position, but vectors of an image change level. As pointed out in col. 10, lines 13-14, the "brightness of these pixels are represented by f(x,y)." The Examiner has not explained how x and y related to position as required by the claim.

Claim 1 further requires "selecting means for selecting a weighting matrix corresponding to the position of the edge of each target pixel determined to have an edge by said detecting means." For this feature of the claimed invention, the Examiner relies on the disclosure of the reference in Figs. 1, 9 and 10, and at col. 10, lines 25-47 and col. 13, lines 28-37 and lines 51-63 of Kuwata et al. The Examiner has not explained how and why features in Figs. 1, 9 and 10

disclose the claimed features. As for the disclosure at cols. 10 and 13, the reference discloses the following:

> In FIG. 9, the X-directional difference value fx and the Y-directional difference value fy are represented by:
>
> $$fx = f(x+1,y) - f(xy) \qquad (2)$$
>
> $$fy = f(x,y+1) - f(xy) \qquad (3)$$
>
> Accordingly, a size g(x,y) of the vector having these components is a vector value represented by:
>
> $$[g(x,y)] = (fx^{**}2+fy^{**}2)^{**}(1/2) \qquad (4)$$
>
> The edge amount is represented by this [g(x,y)]. Note that the pixels are arranged into matrix in the vertical and lateral directions as shown in FIG. **10**, and when the central pixel is regarded as a pixel of interest, there are eight adjacent pixels. Accordingly, it may be arranged such that the differences between the pixel of interest and the respective adjacent pixels are represented by vectors, and the sum of the vectors is judged as the change level of the image. Note that it can be said that the less the number of pixels to be compared is, the less the amount of calculation is. Further, regarding the adjacent pixels arrayed in at least a linear direction, they interact with each other when the position of a pixel of interest moves.
>
> * * *
>
> On the other hand, the edge enhancement level also changes dependent on the size of the unsharp mask. In the three unsharp masks **41** to **43** having different numbers of rows and columns, as the mask is greater, the weighting with respect to the peripheral pixels around a pixel of interest is greater, while the weighting gradually decreases toward distant pixels. In other words, as the mask is greater, the weighting characteristic as a low-pass filter increases, and the generation of high frequency component can be made more easily in accordance with equation (8).
>
> * * *
>
> Note that in the calculation in equation (9), multiplications and additions are required for the number of cells in the unsharp mask **40**, with respect to the pixels around the pixel of interest, and the processing amount is large, accordingly, the unsharp mask is arranged so as to reduce the processing amount. In a case where the unsharp mask **40** of an appropriate size is employed,

> calculation is not necessarily required for all the cells. In the unsharp mask **42** having 7x7 cells in FIG. **19**, the weighting with respect to the outmost peripheral cells is "0" or "1". In case of weighting by "0", the multiplication by "0" is meaningless, while in case of weighting by "1", very low weighted results are obtained in comparison with the total cell value "632".

The Examiner has not explained what the selection means comprises in relation to the prior art. Nor has the Examiner explained how the disclosure of Kuwata et al. would have led a person having ordinary skill in the art to provide a selection <u>means for selecting a weighting matrix</u> and that <u>weighting matrix corresponds to the position of the edge</u> of a target pixel. The Kuwata et al. disclosure refers to a mask having "weighting" values, but it does not disclose a means to select a matrix based on the position of the edge of the pixel as required by the claim.

Claim 1 further requires an enhancement range determining means for determining a range of edge enhancement of each target pixel determine to have an edge. The means makes this determination using the weighting matrix. The Examiner relies on the same disclosure in Kuwata et al. as set forth in the previous paragraph as teaching the enhancement range determining means using a weighting matrix. The Examiner has not explained which unit in Fig. 1 of Kuwata et al. is the means for determining a range of edge enhancement. Fig. 14 of Kuwata et al., which describes the edge enhancement element determination unit, does not refer to using a weighting matrix to determine a range of edge enhancement. The edge amounts are calculated which refer to luminance gradients, and not position of the edges of the pixels as requirement by the claims. The Examiner relies on Equation (8) recited in the paragraph appearing at col. 12, lines. 50-67 of Kuwata et al. as disclosing "a range of edge enhancement …

of each said target pixel determined to have an edge." Specifically, the following disclosure is relied upon:

> Step **S320** is edge enhancement processing calculation. With respect to the luminance Y of each pixel before it is edge-enhanced, a luminance Y' of the edge-enhanced pixel is calculated by:
>
> $$Y = Y + \text{Eenhance} - (Y - \text{Yunsharp}) \qquad (8)$$
>
> In equation (8), "Yunsharp" indicates image data of each pixel which has been unsharp-mask processed. Next, the unsharp mask processing will be described. FIGS. **18** to **20** show unsharp masks **40** (**41** to **43**) of three different sizes. The unsharp mask **40** is utilized for integration on matrix image data, such that the central value "100" is used as a weight for the pixel of interest Y(x,y), and values of the unsharp mask corresponding to the peripheral pixels are used as weights for the peripheral pixels. If the unsharp mask **42** in FIG. **19** is used, the integration is made in accordance with:
>
> $$\text{Yunsharp}(x,y) = (1/632)\sum_{ij}(Mij \times Y(x+i,y+j)) \qquad (9)$$

In the above equation (9), the value "632" is a sum of weight coefficients, "Mij" indicates a weight coefficient given in a cell of the unsharp mask; "Y(x,y)" is the image data of each pixel, and "ij" indicates coordinate values in the row and column directions in the different sized unsharp masks 41 to 43 (col. 13, lines 6-13). According to Kuwata et al. at col. 13, lines 6-13, in "the different sized unsharp masks 41 to 43, the sum of weight coefficients are respectively '396', '632' and '2516'."

The Examiner has not explained how this disclosure recites that a weighting matrix is used in a means for determining the range of edge enhancement <u>of each target pixel determined to have an edge</u> as required by the claim. According to the disclosure of Kuwata et al. at col. 13, lines 28-37,

> In the three unsharp masks 41 to 43 having different numbers of rows and columns, as the mask is greater, the weighting with respect to the peripheral pixels around a pixel of interest is greater, while the weighting gradually decreases toward distant pixels. In other words, as the mask is greater, the weighting characteristic as a low-pass filter increases, and the generation of high frequency component can be made more easily in accordance with equation (8). is not directed to the edges

The Examiner has not explained how Equation (8) in Kuwata et al. can disclose a range of edge enhancement of each target pixel determined to have an edge, when the disclosure of Kuwata et al. appears to teach away from what Applicant describes as their invention in Figs. 12A to 12D of the present specification, which do not show the weighting gradually decreasing approximately the same in all directions from a central pixel.

As for claim 2, which depends from claim 1, the Examiner relies on Figs. 1 and 19 and col. 14, lines 29-63 of Kuwata et al. to show that the enhancement range determining means increases the weighting of components corresponding to the interior side of the edge in the weighting matrix. Col. 14, lines 29-63 disclose the following:

> From the edge-enhanced luminance Y' and the unenhanced luminance Y, substitution is made as:
>
> $$\text{delta} = Y - Y' \qquad (10)$$
>
> Then it is possible to calculate converted R'G'B' from equation (10):
>
> $$R' = R + \text{delta}$$
> $$G' = G + \text{delta}$$
> $$B' = B + \text{delta} \qquad (11)$$
>
> In this calculation, the multiplication and addition become 1/3, thus the entire processing time can be reduced by 50% to 70%. Further, the converted result shows no enhanced color noise and provides improved image quality. Note that the luminance Y is not necessarily obtained with strict weighting as in equation (1). For example, the following equation (12) using a simple mean value does not produce a very large error.

$$Y=(R+G+B)/3 \qquad (12)$$

> For more simplification, it may be arranged such that in equation (1), only the G component having the greatest contributing value to the luminance Y is regarded as the luminance Y. This does not always cause a large error.
>
> As described above, steps **S110** to **S150**, to sum up edge amounts so as to judge the sharpness level of the image, correspond to the summation process unit; steps **S210** to **S250**, to set a threshold value to determine edge enhancement level and to determine a pixel to be edge-enhanced, correspond to the edge-enhancement element determination unit; and steps **S310** to **S340**, to perform edge enhancement calculation on pixels to be subjected to edge enhancement processing, correspond to the edge enhancement unit. Further, the processing by a hardware device and a software program to obtain image data handled in the edge enhancement processing correspond to the image-data obtaining unit.

This disclosure makes no mention or provides not even a suggestion that the enhancement range determining means increases the weighting of components corresponding to the <u>interior side of the edge</u> of in the weighting matrix as required by claim 2. The Examiner has not explained how Figs. 1 and 19 are related to this feature and explained how the disclosure relied upon discloses this feature of the invention.

Claim 3 is dependent on claim 1 and requires that the edge detecting means determines the edge to be between pixels. The Examiner relies on Figs. 1 and 8 of Kuwata et al. Fig. 1 shows the image processor as comprising four units. The Examiner has not explained which unit discloses the feature of claim 3. As for Fig. 8, this figure shows a graph of the relationship between f(x), f(y) and G(x,y). The Examiner has not explained how and why this graph discloses an edge detecting means and that the means determines the edge between pixels. The Examiner further relies on the disclosure at col. 10, lines 5-39 of Kuwata et al., which states:

> At step **S110**, the edge amount of the each pixel is judged. In case of considering an XY rectangular coordinates as shown in FIG. **8**, the vector of a

> image change level can be calculated by obtaining an X-axis directional component and a Y-axis directional component. In a digital image composed of pixels in dot matrix, the pixels are adjacent to each other in a vertical axial direction and a lateral axial direction as shown in FIG. 9. The brightness of these pixels are represented by f(x,y). In this case, f(x,y) may be R(x,y), G(x,y) and B(x,y) as respective RGB luminances or a total luminance Y(x,y). Note that the relation between the RGB luminances R(x,y), G(x,y) and B(x,y) and the total luminance Y(x,y) cannot be converted without referring to a color conversion table or the like, in the strict sense, however, for the simplification of the processing, the correspondence as represented by the following equation is utilized.
>
> $$Y = 0.30R + 0.59G + 0.11B \qquad (1)$$
>
> In FIG. 9, the X-directional difference value fx and the Y-directional difference value fy are represented by:
>
> $$fx = f(x+1,y) - f(xy) \qquad (2)$$
>
> $$fy = f(x,y+1) - f(xy) \qquad (3)$$
>
> Accordingly, a size g(x,y) of the vector having these components is a vector value represented by:
>
> $$[g(x,y)] = (fx**2+fy**2)**(1/2) \qquad (4)$$
>
> The edge amount is represented by this [g(x,y)]. Note that the pixels are arranged into matrix in the vertical and lateral directions as shown in FIG. 10, and when the central pixel is regarded as a pixel of interest, there are eight adjacent pixels.

This disclosure does not address the edge detecting means and that the means determines the edge between pixels. The disclosure does not even refer to the edges of the pixels. The Examiner has not provided any cogent reasoning as to how this disclosure meets this feature of claim 3.

Claim 4 is dependent on claim 1 and recites that the selecting means selects the weighting matrix based on the presence or absence of an edge of a target pixel in four directions

surrounding the target pixel. For this feature of the invention, the Examiner relies on Fig. 8 and col. 10, lines 5-42 of Kuwata et al. The disclosure at col. 10, lines 5-39 is reproduced *supra* in the previous paragraph. The following is disclosure at col. 10, lines 39-42:

> Accordingly, it may be arranged such that the differences between the pixel of interest and the respective adjacent pixels are represented by vectors, and the sum of the vectors is judged as the change level of the image.

Fig. 8 is a graph and does not make any reference to "four directions surrounding the target pixel." Moreover, the Examiner has not presented any cogent reasoning from the disclosure at col. 10, lines 5-42 of the Kuwata et al. as how the figure would disclose the feature of the invention recited in claim 4. The disclosure does not refer to the weighting matrix based on the presence or absence of an edge of a target pixel let alone that that it is based on four directions surrounding the target pixel.

Claim 6 is dependent on claim 1 and requires that the edge enhancing means executes processing based on the distance of the object pixel to the target pixel. For this feature, the Examiner relies on Figs. 7 and 16, and the disclosures at col. 11, lines 14-31 and col. 12, lines 11-34 of Kuwata et al. The disclosures at cols. 11 and 12 state:

> ... More specifically, at step **S120**, the edge amount is compared with a predetermined threshold value to determine whether or not the pixel belongs to an outline portion. Only if the pixel belongs to an outline portion, the process proceeds to step **S130**, in which the edge amount is integrated, and the number of pixels in the outline portions is integrated.
>
> To perform the pixel-based judgment on all the pixels, at step **S140**, the position of pixel of interest is moved as shown in FIG. **7**, and the processing is repeated until it is determined at step **S150** that the judgment on all the pixels has been completed.
>
> When the edge amounts have been summed up as above, edge-enhancement element determination is performed at step **S200**. The edge-

> enhancement element determination is shown in more detail in the flowchart of FIG. **14**.
>
> First, at step S **210**, the ratio of edge pixels is calculated. As the number of outline pixels (edge_pixel) has been integrated at step **S 130**, the ratio of the number of outline pixels (edge_rate) with respect to the number of all the pixels (total_pixel) is calculated:
>
> Edge_rate = edge_pixel/total_pixel
>
> * * *
>
> On the other hand, as image sharpness is sensuous, the sharpness level SL is obtained in a similar manner from image data of an experimentally-obtained optimum sharpness level, then the obtained sharpness level SL is set as an ideal sharpness level SLopt, and an edge enhancement level Eenhance is obtained by:
>
> $$\text{Eenhance} = KS \bullet (SL\text{opt}-SL)^{**}(1/2) \qquad (6)$$
>
> In equation (6), the coefficient KS changes in accordance with image size. As shown in FIG. 7, if the image data is composed of "height" dots in the vertical direction and "width" dots in the lateral direction, the coefficient KS is obtained by:
>
> $$\text{KS} = \min(\text{height},\text{width})/\text{A} \qquad (7)$$
>
> In equation (7) , "min (height, width)" indicates "height" dots or "width" dots as a smaller number of dots. "A" is a constant having a value "768". They have been experimentally obtained and may be appropriately changed. Basically, excellent results have been obtained by increasing the enhancement level as the image size becomes greater.

The comparison made by Kuwata et al. appears to be by comparing the pixel of interest to its immediate surroundings, and not by distance, because the reference discloses that "the process proceeds to step **S130**, in which the edge amount is integrated, and the number of pixels in the outline portions is integrated" and if necessary the pixel is moved. Equations (6) and (7) discuss KS in terms of height and width, but the terms mean the number of dots in the height and width

directions, and not the distances between an object pixel and a target pixel. The Examiner has not presented any cogent reasoning as to how and why the passage above teaches the feature set forth in claim 6.

As for independent method claim 7 and medium readable claim 9 as well as claim 8 which is dependent on claim 7, the arguments made with respect to claims 1 and 2, *supra*, apply to these claims and are incorporated herein by reference. In finding claim 9 unpatentable, the Examiner states that "[a] recording medium that stores computer executable programs in inherently taught as evidenced by computer main body 21 and various memories stored therein." The Examiner relies on computer **21** as having virtual memories. However, for reasons already given, *supra*, Kuwata et al. do not disclose the program steps set forth in claim 9. Claim 11 is an independent claim directed to an apparatus and requires elements similar to those set forth in claim 1. The arguments made with respect to claim 1 apply to claim 11 and are incorporated herein by reference.

For the foregoing reasons, it is submitted that the Examiner has not presented a *prima facie* case of anticipation and that claims 1-9 and 11 are patentable over the teachings of Kuwata et al. It is respectfully requested that the rejection be reconsidered and withdrawn.

Conclusion

In view of the forgoing remarks, favorable reconsideration of the claims is requested and allowance of the claims is courteously solicited.

If there are any outstanding issues that might be resolved by an interview or an Examiner's amendment, the Examiner is requested to call Applicants' attorney at the telephone number shown below.

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To the extent necessary, a petition for an extension of time under 37 C.F.R. § 1.136 is hereby made. Please charge any shortage in fees due under 37 C.F.R. § 1.17 and due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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